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THE Compleat Canonier: OR, The Gunners Guide.

Wherein are set forth Exactly the Chief Grounds and Principals of the whole *Art*, in a very brief and Compendious form, never by any set forth in the Like Nature before.

With divers Excellent Conclusions, both *Arithmetical* and *Geometrical* belonging thereunto: As also sundry serviceable *Fire-works*, both for *Sea* and *Land* Service.

A Study delightfull and very usefull for men of the best Quality, and imbrac'd by the greatest Princes.

VIRTUS GLORIAM PARET.

Written by *JOHN ROBERTS* of *Weston* near *Bath*, *Gentleman*, Practitioner *and* Professor in the *Art* thereof.

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Compleat Cajoler:

&c.

Or, Mens Guide.

To the High and Mighty Monarch, CHARLES, By the Grace of God, of *Great Britain*, *France*, and *Ireland*, King, &c.

SIR,

BEing filled with an admiration of your Royal parts, and a declaratory Fame of the Virtues and Heroick Actions of your Fame-worthy Progenitors; and thoſe tranſmitted unto *You*, by a ſucceſſive, Lineal, and Hereditary right, ſo that that rare Conjunction of *Caſtor* and *Pollux*, I mean *Majeſtas & Ortu & Arte*, are both happily conjoyned in your moſt

Sacred Perſonage. The curious ſurvey of the multitude of your Princely parts breed in me a number of deſires, ſo that I have adventured to break the barren ſoyl of my poor portion; that proſperous ſucceſs ſhould rather want to my endeavours, than diligent endeavours to my loyal determination. My ſubmiſſive allegiance to *Your* Royal and Heroick *Virtues*, have been an encouraging cauſe to deſire Your Majeſties gracious Patronage of this little *Treatiſe of Gunners Art*; but how my unworthineſs may hope of your Goodneſs, I cannot find but in the Notes of Your tranſcendent and gracious Diſpoſition. Thus in the loweſt humility of allegiance, I offer both my ſelf, and the imployment of my undeſerving Service freely to your Higheſs acceptance, and to deſire both to be, and appear to be,

Your Majeſties humbleſt and moſt devoted Servant,

John Roberts.

TO THE RIGHT HONOURABLE, MOUNTJOY,

Earl of *Newport*, Lord *Mountjoy*, Maſter of His Majeſties Ordnance.

Right Honourable,

THe *favourable countenance and furthering Reſpect which my Predeceſſors received of that renowned General, and ever memorable and remarkable Martialiſt, the Right Honourable the Earl of* Devonſhire, *of never dying Memory, your Lordſhips late deceaſed Honour'd Father, together with the Duty and Oblegiance, all thoſe of my Quality owe unto your* Honour, *by reaſon of the Place and Dignity moſt deſervedly You are in, and called to; makes me of* Socrates *Opinion, in acknowledging all my utmoſt*

moſt not able to reach the half height of your Lordſhips Favour: Wherefore labouring like the Bee, ſucking from the choiceſt Flowers the beſt Honey I can gather, the night of reſt being come, I bring it to the Hive of your kind acceptance, and there leave it, as much labour beſtowed about little, till diligent employment may more amply increaſe it. Right Honourable, *I am loath to be troubleſome, eſpecially where affable Gentleneſs out-paceth any merit in my Self: Therefore preſenting your Lordſhip with this Treatiſe of* Gunners Art, *and my attendant Service, when it ſhall pleaſe your* Honour *to imploy me; and praying devoutly for the endleſs proſperity of You, and yours, I humbly conclude,*

Your Honours, in all duty
to be commanded,

John Roberts.

THE
Compleat Canonier;
And firſt, of principles of *Philoſophy fit to be known.*

ALL motions or things moveable end in their reſt or repoſe.

So all motions are made upon ſome quantity continually.

Every ſimple body is either bright and light, or elſe groſs, dark, and ponderous: and according to the variety and differences, it is alwayes naturally carried towards ſome one or other part.

The World hath heighth as upwards, or depth as downwards; and the depth dependeth upon the influence of the height,

All pure and rare Bodies aſcend, as the fire more than the air; but the thick and groſs bodies deſcend, as the Earth more than the Water.

Nothing worketh naturally in that which is wholly like, or wholly diſlike, but in that which is contrary to it, and more feeble.

The form working is aided by the qualities, as the matter ſuffering, which ſuffereth by the quantity.

Nature is extremely curious as well of her perfection, as of her conſervation, and then when all things conſpire.

As well the action that cometh from the Agent, as the paſſion from the Patient hath proportion.

Accident taketh his unity from the Subject, and goeth not from one thing to another.

Every Corporal thing repoſeth in its natural place, motion may be made any where within the *Moons* Orb, nature admitteth no Emptineſs.

A body rarifying its ſelf, the place thereof increaſeth as the body increaſeth.

The reſiſtance of the moved, proportioned to the mover, furthereth the motion.

The longer the chaſe of a Piece, the louder the report.

Alſo the force of the ſtroke dependeth on the ſwiftneſs of the courſe.

A Table of the Square.

1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	64
9	81

Table of Cubes.

1	1
2	8
3	27
4	64
5	125
6	215
7	243
8	512
9	729

How to extract the Square root.

SEt down any number as comes into your mind, as thus, 2 1 6 0 9. Then begin at your right hand, and put a prick over the firſt figure, and then over the third, as you ſee above done; and ask what is the ſquare

root

root of 2. which is as many figures as you have under your firſt prick, and you ſhall find but 1. then put that figure in the quotient, and ſubſtract that 1. out of 2. ſo remaineth 1. then double your quotient, and ſet that double under your ſecond figure, dividing the number over by that double. But take heed you leave enough to take the ſquare of that fignre laſt left in the quotient, and divide as afore; then ſquare your third figure in the quotient again, and ſubſtract it out of the remainder, ſo have you done this ſum. Look how often you have pricks, ſo often muſt you double and multiply ſquarely, and ſubſtract alſo; ſo many figures alſo will there be in the quotient, as there are pricks. And conſequently of any number whatſoever.

To know the neareſt root of a number not ſquare.

IF any fraction remain, by diligent obſervation of this, you may come as near as you would deſire in any practick, to gueſs within leſs than ordinary is known. Set next your right hand after your ſum, either two, four, or ſix cyphers, the more, the leſſer your error, and the nearer by much ſhall you come unto the root, obſerving the ſame manner in working as you you did before.

And now I will ſhew you by particular Queſtions in the art Military, how neceſſary it is for any one intending to be a compleat martial man, to have good judgement in the extraction of the ſquare and cubick roots, and alſo in the depth of Arithmetick, and what excellency of knowledge is attained unto thereby, and how far they are from being Souldiers, as are ignorant thereof.

The first Queſtion.

A General having 3 great Armies, would caſt them into three ſquare battails, but he knows not how many men he ſhall ſet in the front of each battail.

The number of the 3 Armies are theſe, in the firſt there are 5625. in the ſecond 9216. and in the third 15129.

To do this, you muſt extract the root of every Army ſeverally, ſo have you your deſire.

In the firſt you have 75. men ſquare, in the ſecond 96. men, and in the third 123.

If you were commanded to make a ſquare battail of all three Armies, add them firſt together, then extract the ſquare root; and if any remainder be, you may imploy them where you pleaſe.

The ſecond Queſtion.

A King hath a great Army in a Valley, that in marching the front can be but 18. men, and the flank 44352. which he is deſirous to caſt into a ſquare battail.

Multiply the flank by the front, ſo have you the full number of the men: then extract the ſquare root thereof, ſo have you what can be deſired.

The third Queſtion.

A General hath 3 Armies in the Field, to the number of 28289. men, and none of theſe three apt to make a ſquare battel; the Serjeant Major is Commanded by his General to ſet them in three ſquare Battels.

Theſe are the 3 Numbers of the three ſeveral Armies: In the firſt there are 10296. men: in the ſecond 9493. and in the third 8500. men.

Mark this ſeriouſly, for it is not ordinary; you ſhall find more exquiſite Work than you imagine, becauſe the queſtion is more difficult.

Firſt,

Firſt, extract the ſeveral roots of the three Armies.

Then take the greateſt ſquares of all three numbers, 10201, and his exceſs 95, together with his root, which is 101.

In the ſecond the greateſt ſquare is 9409, and his exceſs 84, and his root 97.

In the third, the greateſt ſquare is 8464, his exceſs 36, and his root 92. And thus have I found the three exceſſes.

Now for to end the three defaults or wants, I add one to each root, and multiply them ſquarely, and ſo of 102 I find the Square to be 10404; and if I ſubſtract the firſt number, which is 10296, out of it, there will remain 108 for the firſt want, and thus do by the other two, ſo your exceſſes and wants will be as are here ſet down in particular.

	A	B	C
Exceſſes	95	84	35
Wants	108	111	149

Here I compare the exceſſes with the wants, to ſee if any two exceſſes will make up the others want, and I ſee by a light proof it will not juſtly ſerve.

As for the wants, I do not compare them to the exceſſes, for every want is greater than the exceſs: therefore two wants far too great for one exceſs.

Wherefore when this Rule faileth, take the two wants of any two numbers, and add them firſt together, then abate them from the third number, and if the remainder be a ſquare number, you have gotten your deſire.

As for example, take the wants of the firſt and ſecond, which makes 219, and that do I abate from the third number 8500, and there remains 8281, which I ſee may be a ſquare number, and 91 the root thereof.

Wherefore I ſay, that theſe three numbers following ſhall be the roots of the ſquare battels, as here I have ſet them.

The

The firſt battail 10404, *and his Front* 102.
The ſecond battail 9604, *and his Front* 98.
The third battail 8281, *and his Front* 91.
The ſum total of all the 3 battails 28289. men.

The fourth Queſtion.

A General having 3 Armies in three ſeveral battails, in the firſt 4900 men, in the ſecond 2401, and in the third 2500. ſo that the greateſt is as much as both the other, except one man, and he is inforced to joyn all three battails into one, but is in doubt whether he may have good and convenient ground to encamp them in form of battail. Wherefore conſidering that all three battails together are but double to the greateſt of the three alone: The Serjeant Major deſiring a meet ground for his Army, ſo joyned in ſquare battail, is in doubt what ſquare of ground will ſerve his purpoſe; but ſure he is, that it muſt be double to the ground, that the greateſt Army of the three did uſe, and that was every way 210. foot: wherefore his demand is how many foot ſquare ſhall the ſide of that ground be, that is double to the former ſquare, whoſe root was 210 foot.

To double a ſquare.

Firſt, multiply 210 by it ſelf, and ſo have I the juſt plat of ground of 44100. foot; that muſt I double, and it will be 88200, and out of this number ſhall I ſeek (as before is taught,) the higheſt ſquare root. For juſt ſquare I ſee it is not, by reaſon that after the even cyphers, there followeth the figure 2. which is one of thoſe figures that cannot begin any ſquare number, therefore (as I ſaid above) you muſt ſeek the neareſt ſquare root, which for brevities ſake, and becauſe I have ſufficiently already treated of, do leave it to your beſt leiſure to practiſe. Infinite more Queſtions tending to this purpoſe, could I ſet down, but that time will

will not permit, or my intended little Volume contain, therefore I will proceed to ſhew you the extraction of the Cubick root, which will be much to the purpoſe and ſubject I am now to treat of.

How to extract the Cubick root.

FIrſt, begin at your right hand, and ſet a prick over the firſt figure, then another over the fourth, ſo leave two figures unprickt, and prick the third ſtill until you have done thus, 7 9 8 6 4 3 4 5. As many pricks as are over the number, juſt ſo many figures will there be in the quotient.

1. Then ask what is the Cubick root of the firſt prick, and ſet down that in the quotient: and if it be ſo that root doth not take all away of the number from the firſt prick, ſubſtract as much as the root containeth, and ſet the remainder over head the figures which ſtood there before, being cancelled.

2. Then triple your quotient, and that triple you ſhall ſet under the next number towards your right hand, before that prick which you did laſt end.

3. Next, multiply that triple by the ſame quotient, and ſet it down under the firſt triple, and that number ſhall be your Diviſor.

4. Now muſt you look out a quotient that may declare how often the diviſor is in the number over it.

5. This being done, you muſt multiply the laſt figure in the quotient by your diviſor, and ſet it under your diviſor, with a line between.

6. Then multiply the laſt figure in the quotient by it ſelf, and then in the triple, and ſet that product below the former one figure more towards your right hand.

7. Laſtly, multiply the laſt figure cubically, and ſet that ſum alſo one figure nearer the right hand: then add all theſe three multiplications together, and ſubſtract

ſtract it out of the firſt and ſecond pricks; I mean, out of all thoſe figures unto the ſecond prick: this done, triple all your Quotient, and divide as before, and as you did by the firſt and ſecond pricks after your diviſion, ſo do by the reſt, and you have obtained your deſire. Look upon this following Example.

To find the neareſt Cubick root and cubical.

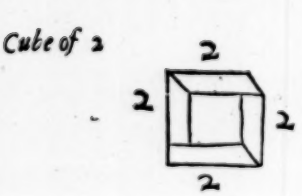
You muſt do it by addition of cyphers (as is ſpoken of before in the ſquare-root) in ſuch ſort, that they muſt be alwayes ternaries, as 3 or 6 or 9 or 12, and then proceed with the like order of work, as before.

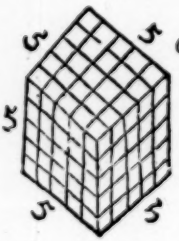
	18
	26463592 (29
	6
	12
	108
	486
	729

A Queſtion of doubling a Cube.

IF the ſide of a Cube be 3 foot, how many foot ſhall the ſide of that Cube be, which muſt be double unto it? Firſt, find the quantity of that Cube that is propounded, and then double that quantity; laſtly, extract the Cubick root of that double number.

As for Example, The Cube is 3, and therefore the whole Cube is 27, whoſe double is 54, and the Cubick root is 3 foot, and $\frac{77}{100}$ and $\frac{1}{7}$ of $\frac{1}{100}$.





A Queſtion of two Cubes.

A Cube of braſs of four inches ſquare, doth weigh 7 pound weight, what ſhall a cube of braſs of nine inches weigh?

The proportion of their ſides are as $\frac{4}{9}$, which I muſt ſet down twice, and multiply them together as fractions ſhould be, and ſo it will be thus $\frac{4\cdot4\cdot4}{9\cdot9\cdot9}$ that maketh $\frac{64}{729}$.

Wherefore I multiply the weight of the leſſer Cube, being 7, by 729, and it maketh 5103. and that do I divide by 64, and ſo find 79 $\frac{47}{64}$, whereby I may know, that the weight of the great Cube is 79 pound, and near $\frac{3}{4}$ of a pound,

A *Queſtion of a Gun.*

A Gun of ſix inches daimeter, doth ſhoot a bullet of twenty pound weight; what weight ſhall that bullet be, that ſerves for a Gun of 14 inches in diameter?

All Globes bear triple that proportion, that their diameter does. So in this example, the proportion of their diameters being as 14 to 9, or as 7 to 3, I ſhall triple it, and then have I the proportion of there globes. Euclid. Some take more, as now is found.

Wherefore I ſet the three fractions thus, $\frac{7}{3}\frac{7}{3}\frac{7}{3}$, and they make $\frac{343}{27}$, that is 12 $\frac{19}{27}$, when you have divided the Numerator by the Denominator. And ſo is the proportion of the globes, as well in weight as in bigneſs. Therefore I multiply 20, that is in the weight of the leſſer, by the Numerator of the proportion, and divide it by the Denominator: and ſo ſhall I have 254 $\frac{6}{27}$ for the weight of the greater bullet.

Another Queſtion of a bullet.

A Bullet of Iorn of ſeven inches diameter, weghed 27 pound, what ſhall be the diameter of that bullet that ſhall weigh 125 pound?

I ſet down $\frac{125}{27}$ and I ſee the Cubick root of 125 is 5, and the like root of 27 is 3; which numbers I ſet in the room of the other thus, $\frac{5}{3}$ which declare the proportion between the diameter of the two bullets; the diameter of the leſſer is known to be 7, therefore I multiply that 7 by 5, whereof cometh 35; that divided by 3, yieldeth in the quotient 11.

The Proof hereof.

Multiply both roots cubically, if their roots be in proportion as their weights, then is your work true, elſe not. As for example, 7 multipli'd cubically, makes 343, and $11\frac{2}{3}$, multipli'd alſo cubically, makes $428\frac{21}{27}$.

To multiply a fraction cubically, as $11\frac{2}{3}$, firſt, reduce it, and make it 35: that 35 multiply cubically, you have your deſire.

How to turn a whole number into a fraction of the like denomination.

Suppoſe 7 is the number you deſire to turn into the like denomination, that $\frac{2}{3}$ (as above) is of, multiply 7 by 3, the denominator of the other fraction, and it maketh 21, that 21 multiply cubically, and it will be $\frac{9261}{27}$: Theſe few Rules diligently obſerved, will much enable an Artiſt to perform many things belonging to this Subject, alſo much benefit, experience, and delight, ſhall any man reap, that hath judgment to try and practiſe the ſecrets thereof.

A Queſtion of whole numbers and fractions.

A Faulcon of 2 inches in the diameter ſhoots a bullet of 3 pound, what ſhall the Culvering ſhot weigh, whoſe diameter is 5 inches $\frac{3}{4}$.

To anſwer this and all ſuch queſtions that muſt be cubically multipli'd, you muſt reduce each bullet into

into his proper fraction. As for example, $2\frac{1}{4}$ maketh $\frac{9}{4}$ and alſo $5\frac{1}{4}$ maketh $\frac{21}{4}$, then I multiply each numerator cubically, and I find the Cube of the leſſer to be $\frac{729}{64}$ and the Cube of the greater to be $\frac{9261}{64}$. Then I ſet down 3, the diameter of the leſſer fraction, like as before, thus, $\frac{3}{1}$ which being wrought punctually by the Rule of Three in fractions, you ſhall have for the weight of the bigger bullet 20 pound, and almoſt $\frac{1}{4}$.

How you may Geometrically find out the Diameter of any bullet that weigheth twice ſo much as a known bullet.

TAke the true weight or diameter of the leſſer bullet, whoſe weight you know, and ſquare the ſame, as in the figure following: Then draw a line that may divide the ſaid ſquare into two equal parts, in the two oppoſite angles, and that line ſhall be the diameter of a bullet, twice the weight of the other; then divide that diametrical line in two equal parts, ſetting one foot of your Compaſs in the centre, and with the other foot draw a circle; and that circumference will repreſent a bullet, twice as much in weight as the leſſer.

To prove it Arithmetically.

THe diameter of the leſſer bullet is 5 inches, the ſquare 25, the ſum double is 50, the ſquare-root of 50 is 7 and ſomewhat more, and ſo much is the diameter of the greater bullet.

By one Bullet to know the weight of another, the Diameter given.

A Canon of ſeven inches ſhoots a bullet of 32 pound: I demand what weight that bullet ſhall be of, that is nine inches in the diameter?

Multiply the diameter of each bullet cubically, as 7 times 7 is 49, and 7 times 49 is 343; then 9 times 9 is 81, and 9 times 81 is 729: then by the Rule of three ſay, If 343 give 32 pound, what ſhall 729 give? Multiply and Divide, and your quotient will be 68 $\frac{48}{343}$.

How by the weight of one Piece, to know the weight of the other.

IF a Minion of three inches bullet weigh 500 pound, I demand how much a Canon of 8 inches bullet will weigh, that is able to receive his proportial charge to the Minion. The Cube of 3 is 27, the Cube of 8 is 512: Now by the Rule of Proportion ſay, If 27 give 512, what ſhall 500 give? Multiply 512 by 500, and divide that product by 27, and you will have in the quotient 9481 $\frac{13}{27}$ the true anſwer to the queſtion.

The Canon therefore that ſhall be able to carry a proportional charge to the Minion, muſt have 9481 $\frac{13}{27}$ pounds of metal: but becauſe commonly thoſe greater ſorts of Ordnance are not ſo maſſie of metal as indeed they ought to be, the Gunners obſerve this for a general rule, that in all Pieces of above 6 inches in bore, they abate $\frac{1}{4}$ of their ordinary charge.

To know how many ſhots of Powder will be in a grand Barrel of powder, for any Piece.

SUppoſe a Culvering ſhoot 10 pound at one ſhoot, how many times will a grand Barrel of Powder ſerve,

ſerve, the Barrel holding three hundred weight?

Example.

Divide 300 by 10, the quotient is 30, your deſire.

The Proof.

Multiply 30 by 30, or 30 by 10, gives 300. So may you know for all other ſorts of Ordnance whatſoever.

By knowing what Powder a Piece muſt have, to know how much a Piece of another bore will require; but, Cave.

IF a Minion of 3 inches the bullet, requires 3 pound of powder for his charge, what powder will a Canon of 8 inches bullet require?

Multiply 512, the Cube of 8, by 3, the charge of the Minion, and it maketh 1536, which divided by 27, the Cube of 3, the Diameter of the ſaid Minions bullet, ſo have you in the quotient 59 $\frac{4}{27}$; ſo many pound of powder is the due charge of your Canon: But by the Rule afore-ſaid, you find the Canon hath not his proportional metal, therefore you ought to abate $\frac{1}{4}$ of the Powder, ſo will there remain 44 pounds, or near, for your Canons charge.

To find the Superficies of a Bullet.

FIrſt, by a pair of Callibres find out the Diameter, which ſuppoſe it be 7, then muſt the circumference be near 22; but for ſpeedy work, and to avoid a tedious diſcourſe thereof, being that no greater error enſueth thereby, take 22: now multiply that number by 7, it produceth the ſuperficial content of that Globe, Ball, Boul, or Bullet,

A Table ſhewing the weight of all Iron Bullets, in Haberdepoize weight.

Height of the Shot in inches and parts.	Weight of the Shot in pounds and parts.	Height of the Shot in circles and parts.	Weight of the Shot in pounds and parts.
Height.	Weight.	Height.	Weight.
2	1 1/7	5 1/8	19 1/3
2 1/4	1 1/2	5 1/2	22 1/7
2 1/2	2 1/2	5 3/4	25 1/6
2 1/4	3 1/2	6	29 1/2
3	4 1/2	6 1/4	32 1/8
3 1/4	5	6 1/4	40 3/4
3 1/2	6 2/9	7	46
3 1/4	7 2/7	7 1/4	52 2/7
4	9	7 1/2	56 1/8
4 1/4	10 1/4	7 3/4	64 1/2
4 1/2	12 2/3	8	70
4 1/4	14 5/8	8 1/4	76 2/3
5	16 1/4		

To find out how many ſquare inches are contained in a ſolid content of a bullet, and conſequently, how many pound weight.

THere is a bullet, whoſe diameter is nine inches, how many ſquare inches are there in the ſolid content? Multiply

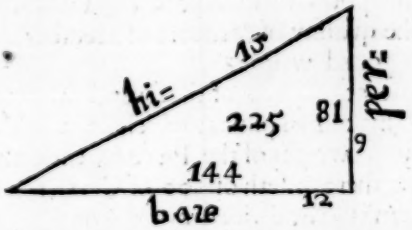
Multiply the diameter 9 cubically, ariſeth 729, which multiply again by 11, maketh 8019: that divide by 21, yieldeth 381 inches and $\frac{6}{7}$: ſo many inches are in a bullet of 9 inches diameter. Now to know how many pound weight is contained in that global body, multiply that quotient 381 $\frac{6}{7}$ by 4, and divide by 16, it will ſhew how many pounds of Iron that bullet weigheth: for an inch ſquare of caſt Iron, weigheth 4 ounces *ferè*

To find out the true content of a Circle.

TAke the one half of his diameter, and multiply it in one half of the circumference, and it produceth the *Area*, or ſquare the diameter, and multiply the product by 11, and divide the reſult by 14, and it alſo ſheweth the content.

Arithmetically to find out the mean proportion between two numbers.

MUltiply both numbers one in another, and then extract the ſquare-root, ſo have you the mean proportional.



Suppoſe the line given is 12, and the perpendicular 9: now you muſt multiply 12 in it ſelf, and it maketh 144; then

then multiply 9 in it ſelf, and it maketh in product 81; then add both the multiplications together, and it maketh 225. Laſtly, extract the Square-root, and it leaveth 15, the juſt length of the hypothenuſal ſought.

Geometrically to find out the mean proportion between two lines.

EXtend one of the lines to the number of inches he is in length, upon the end whereof erect a prependicular to the juſt length of your other ſuppoſed line: then that line which is the hypothenuſal to them both, is the mean proportional.

The Hypothemuſal and one ſide given, to find the other.

MUltiply each number in it ſelf: then ſubſtract the leſſer out of the greater, the Square-root of the remainder is the true length of the third ſide.

Arithmetically to know how much of every ſort of Metall is in a piece of Ordnance.

FOr every hundred pound wight of Copper, to put in ten pound of Lattin and eight pound of Tin. I demand the quaintty of each ſort of Metal in a Culvering of 5600 pound weight?

Note, that I joyn all of the ſeveral mixtures together, and they make 118 pound. which is my Diviſor: then I multiply the weight of the Piece by each mixture ſeverally, and there ariſeth of 100 of Copper 560000: the which ſum is to be divided by the Diviſor 118, and the quotient is 4745 and $\frac{20}{118}$ parts, ſo much Copper is there in that Ordnance, and thus muſt you do to know how much you have of the other two ſorts of Metall.

To

To prove this, add all three quotients together, if they make the ſum before mentioned, it is right.

The Lattin doth incorporate, and cauſeth the piece to be of a good colour, and the Tin doth ſtrengthen and bind the other mixtures together.

To find the ſuperficial content of the hollow concavity of a piece of Ordnance.

SUppoſe the Diameter be 7. inches, and the Cilinder 12. foot, what is the content ſuperficial ?

Reduce the Cilinder 12. foot into inches, maketh 144. which multiplyed by 22. the circumference of the muzzle ariſeth 3168. the ſuperficial content of the metall compaſſing the hollow Cilinder.

To find the traſſitude, or ſolid content of the Cilinder of any piece.

FIrſt multiply one half of the Diameter, in one half the Circumference, or elſe ſquare the Diameter, and multiply that product by 11. and divide the reſult by 14, the quotient will ſhew you the content : the which multiply in the length of the Cilinder, the product is your deſire.

If you deſire how many foot in ſquare meaſure it contains, divide the number of inches in the ſolid content by the number of inches in a foot ſquare which are 1728, your queſtion is reſolved.

To meaſure any ſort of Timber.

SUppoſe your Timber be 8. inches one way, and 6. inches another way, and you are deſirous to know how many inches in length will make a foot ſquare.

Multiply 8. by 6. and it maketh 48. which number

divide 1728. (becauſe there are ſo many inches in a foot ſquare) and you ſhall have 36. inches in the quotient, ſo many inches long will make a foot ſquare of Timber. Thus of all other cubically.

A Table how to weigh a great deal with few weights.

You may weigh any number of pounds from

- *One to 40. with theſe 4 weights.* 1, 3, 9, 27
- *One to 121. with theſe 5. weights.* 1, 3, 9, 27, 81
- *One to 364. with theſe 6. weights.* 1, 3, 9, 27, 81, 243

The pounds to be weighed, are weighed with as many namelike weights, to be done either double or threefold: ſometimes by adding one weight to another, and ſometimes by taking away and adding to the contrary balance.

To

To measure any sort of board, glass, pavement, &c.

FIrst multiply the breadth by the length, as a board is 17. inches one way, and 139. inches another way, multiply 136. by 17. and it maketh 2363. which divided by 144. leaveth in the quotient 16. foot and $\frac{11}{144}$ parts of a foot. Note that in flat measure there is but 144. inches in a foot, but in square measure 1728.

To measure Land.

MUltiply the breadth by the length (if square or long square) and divide the product by 160. because there is 160. square perches in an acre, so shall you come to the *Area*, but if your ground be irregular, you must cast it into triangles; and if it be a right angled triangle, multiply half the perpendicular by the whole base, and divide it by 160. but if it be an obtuse triangle, let fall a perpendicular from the obtuse angle to the base, and multiply half the length of that perpendicular by the whole base, and divide by 160. as before, you have the content.

Also if you have a piece of Land to set out, as to know if it be 12. Perches in breadth, how many perches it should be in length, say by the backward rule of 3. if 4. gives 4. what shall 12. give? multiply 4. by 40. makes 160, which divide by 12. and it giveth 13. perches, and $\frac{1}{3}$ so of all such like.

To measure any irregular substance whatsoever, as a Crown, Horse-head, or any Image, or concaved piece.

TAke a vessel that is very stanch, and 4. square, and put water into it, and when the water is setled,

mark with your knife how high it riſeth in the Veſſel, and then put in your irregular form whatſoever it be, and mark with a knife again how high the water then bears, or riſeth; then take out the irregular form again, and meaſure exactly the ſpace between the marks, and multiply the breadth by the thickneſs, and obſerve the length, and you have your deſire.

How by knowing the weight of one Fathom of Rope, to know the weight of another.

A Cable of 10. inches compaſs weighing 16. pound every Fathom, how much will a Fathom of that Rope weigh that is 15. inches in the Diameter, and made of the ſame ſtuff?

Multiply 15. the greater in it ſelf maketh 225, and that multiplyed by 16. the weight of a fathom of the leſſer Rope, maketh 3600. which divided by 100. being the ſquare of the leſſer rope, leaveth in the quotient 36. pound, the true content.

By the compaſs of any ſmall Rope, to find the Diameter and weight of one, four, five, or ſix times as big.

SUppoſe the ſmall Rope is 3. inches compaſs, and that it is required to know the height of another 5. times that compaſs, multiply the number 3. ſquarely ariſeth 9. which multiply again by 5. maketh 45. then extract the ſquare root thereof, and you ſhall have 6. $\frac{3}{4}$ ſo much in Diameter is the greater; that done, you may as before find his weight and circumference.

How to know what empty Cask will carry any ſort of Ordnanse over a River.

IT is thought ſufficient, 5. Tun of Cask will ſwim a Canon of 8. or 9000. weight, 4. Tun a Dimi-Canon, 3. Tun a Culvering, and two Tun a Saker, accounting all proviſions to be made faſt thereunto, as planks and ropes.

How by knowing what powder a few Pieces ſpend, being ſeldome diſcharged, to know how much many of the ſame will ſpend being often diſcharged.

IF 4. Canons be twice diſcharged, and ſhoot 240. pound of powder, how much powder will ſerve 5. Canons, to ſhoot every one 6. ſhot, work by the double rule of 3. and ſay, if four Canon ſhoot 240. pound, what ſhall 5. do? and you ſhall find 300. then ſay again, if 2. gives 300. what ſhall 6. give? multiply and divide, and you ſhall have in the quotient 900.

To know how much powder each Canon ſpent in the former concluſion at a ſhot.

MUltiply 4. the number of Guns firſt propounded, by 2. the number of time they were diſcharged, ariſeth 8. by which divide 240. the quotient will be 30. which they ſpent at a time.

The proportions between Bullets of Iron, Stone, and Lead.

A Bullet of Iron to the like Bullet of Marble, is in proportion as 15. is to 34.

A Bullet of Lead to the like of Iron, is in proportion as 28. to 19.

A Bullet of Lead to the like of Marble, is in proportion as 4. to 1.

By knowing the Diameter and weight of an Iron Bullet, to find the weight of a Bullet of Marble.

ADmit an Iron Bullet weigh 9. pound, of 4. inches high, what ſhall a Bullet of Marble weigh of like Diameter?

He ſhall have ſuch proportion as 34. to 15; therefore multiply 9. by 15. the proportion of the Stone-bullet beareth, and there ariſeth 135. which divided by 34. the quotient is 3. pound, and $\frac{17}{34}$ parts of a pound.

How to know Arithmetically where to place the Trunnions of any piece of Ordnance.

MEaſure the length of the bore of the piece from the Muzzle to the breech; divide that meaſure by 7. and multiply that ſum that cometh of the quotient by 3. the product will ſhew you how many inches the Trunions muſt ſtand from the loweſt part of the concavity of the piece.

And further note, that the Trunions ought to be placed as $\frac{1}{3}$ of the circumference of the piece may be ſeen in that place where the Trunions are ſet.

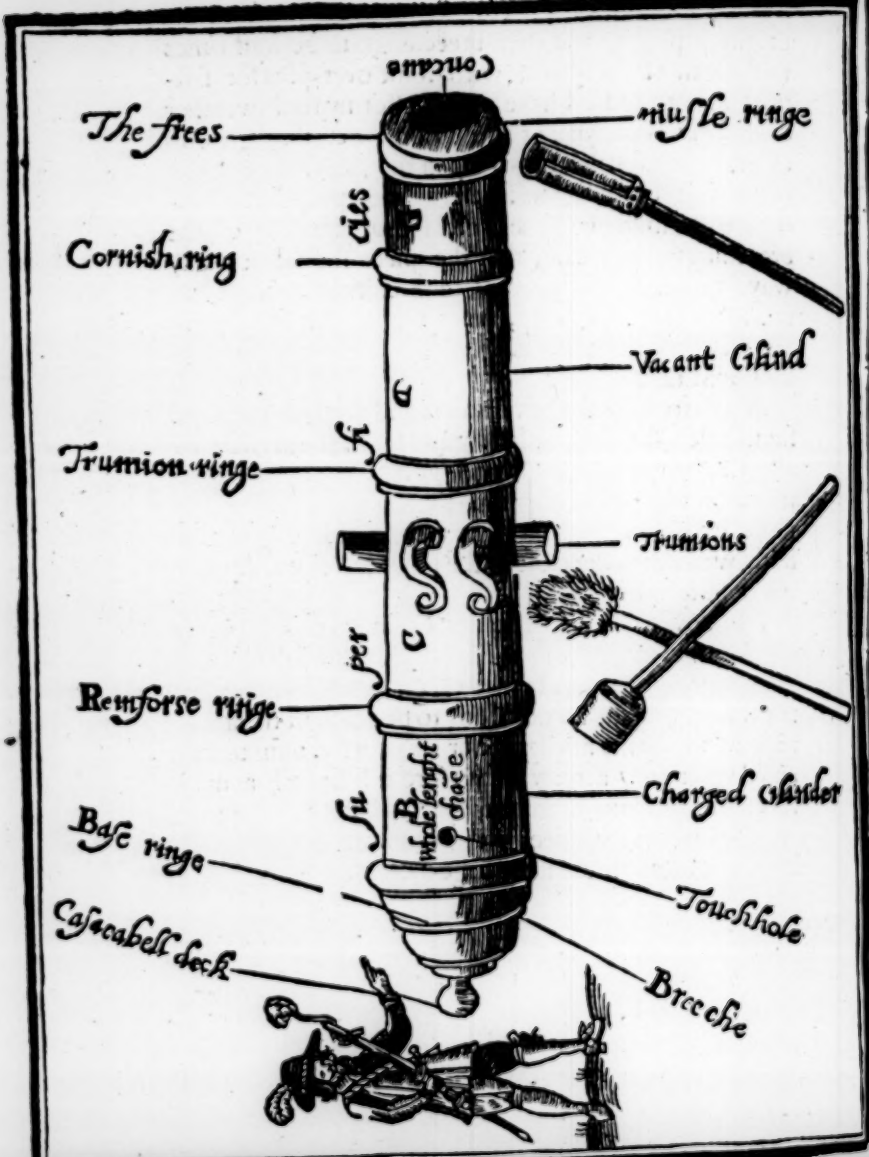
How much rope will make breeches and tacklings for any piece.

IT is a rule, though not obſerved by the vulgar, yet by the moſt experienced Sea-Gunners, that look how many foot your piece is in length, ſo many fathom of rope muſt there be in one tackle for ordinary or extra-ordinary

ordinary pieces, and their breechings to be four times the length of the piece, with ſome over-plus for faſtning at both ends. I have againſt ſtormy foul weather cauſed divers quoyners to be bored twice through with an augor, and nailed down upon the deck, the thickeſt end cloſe as could be the fore trucks, of purpoſe to hinder (what might be) the ſtretching or ſtraining of the breechings and tackle, that the piece ſhould not any way ſwerve. But if your piece accidentally break her tacklings and breechings, you have no better way for the preſent to prevent danger, but with expedition to diſmount her.

Alſo I could wiſh the rammers and ſpunges made of ſmall haſer, ſhould (for laſting and for the better ſerivce alſo) be armed cloſe and hard with ſtrong twiſted yarn from the rammers end quite to the ſpunge, which would much ſtiffen, and make it more uſeful and laſting to ram both wad and bullet cloſe to the powder, eſpecially being done in time.

I do adviſe all his Majeſties Gunners of the Navie to take an eſpecial heed, and diligent care in the election and chooſing of the Yeoman of the powder-room, by reaſon he is upon all occaſions to be amongſt the amunition: for by his negligence or diſhoneſty, infinite loſs and danger may accrew; therefore it is fit ſuch a man ſhould be firſt known to be a loyal ſubject, and one that would perform the office with both care and diligence before he be admitted the charge thereof.


Concave
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whole lenght chace
Charged Cilinder
Baſe ringe
Touchhole
Caſacabell deck
Breeche

The Names of the principal Members of a Piece of Ordnance.

FIrſt, the uppermoſt part round about the Piece, may be called the Superficies of her metal; the ſubſtance or whole maſs of metall, the Body; the hollowneſs thereof, the Concave, Cilinder, or Soul: the whole length, the Chaſe: So much of her Bore as containeth her powder and ſhot, is the Chamber, or charged Cillinder; the remainder, her vacant Cillinder; the Spindals or Ears are called her Trunions; and the ſpace between them, the gravity of her Centre; the pumel at her coyl, the Caſacabel, or her Deck: the little hole, the Touch-hole: all the metall behind the Touch-hole, her Breech or Coyl; the greateſt Ring at her Touch-hole, her Baſe-Ring; the next Ring, or Circle, is the reinforc'd Ring; the next to that, the Trunion-Ring: and the Circle fore-moſt, her Muzzle-Ring: Laſtly, the Ring between the Trunions and Muzzle-Ring, is called the Corniſh-Ring; and all the Rings, Circles, and Eminencies at her Muzzle, are called the Friez, as you may ſee in the Figure juſt againſt this matter.

What Inſtruments are moſt fit for a Gunner.

THe Calabre Compaſſes, height-board, inch ſight-Rule, Gunners Scale, Gunners Quadrant, divided into 90 degrees, and into 12 points, and their minutes, with a Geometrical Square to take Mountures, Levels, Heighths, Breadths, and Diſtances: a pair of ſtreight-pointed Compaſſes, with a little Braſs Level, Scales, and Weights, Primidg Irons, Moulds to make Croſs-bar ſhot for Muskets, a fair Book for your Accompts, and an Iron, with a Spring and a Tranſome to diſpart a

Piece of Ordnance; let the Tranſome be to go up and down, according to the diameter and thickneſs of any Piece; let the Tranſome be long enough to reach the Baſe-ring from the Touch-hole. This Inſtrument is very neceſſary, though not commonly known.

How to Load and Fire a Piece of Ordnance like an Artiſt.

HAving all things fitted, and in readineſs prepar'd for ſervice, firſt, mark the wind, and be ſure to lay your budge-barrel, and the reſt of your powder to weather your Piece, then place your Lint-ſtock to leawards, having clear'd the Touch-hole, ſpunge her well, ſtanding by the right ſide of the Gun, and when he draws out the ſpunge, ſtrike two or three blows upon the muzzle, to beat off the foulneſs of the ſpunge; then his Aſſiſtant declining the budge-barrel aſide, he ſhall thruſt in the Ladle to fill it, ſtriking off the heaped powder, and giving a little ſhog, the better to ſettle the reſt in the Ladle; ſo being filled and ſtriked, ſtand by the right ſide of the Piece, (as clear as he can from the muzzle) and put in the Ladle to the bottom of the concave very ſteddy, quite home to the touch-hole, and when it is arrived to the bottom of the bore, laying your right thumb upon the upper part of the Ladle-ſtaff, turn the ſtaff, untill your thumb be quite under it, and give a ſhake or two to free the Powder from the Ladle, bearing him up, that none may come out again: Then put the powder home ſoftly with the Rammer, after which, put in a good wad, and thruſt it home to the powder, giving three or four hard ſtrokes, which will gather the ſcatter'd powder together, that it may fire the better, the Aſſiſtant having a thumb upon the Touch-hole all the while,

while, then put in the ſhot, which with a Rammer he muſt put ſoftly home, and afterwards another wad, and then give two or three good ſtrokes with the Rammer more, to ſettle all cloſe together, that there may be no vacuity between powder, firſt wad, bullet, or laſt wad: This done, place your Budge-barrel again to wind-wards, and be ſure to weather your Piece in the fireing, to prevent all danger. Laſtly, have ſpecial care in directing her to the mark, and in priming her, let the powder come from the Touch-hole to the Baſe-ring, ſo may you fire there ſafely, without danger of the fire of the Touch-hole to force your Lint-ſtock out of your hand, provided you draw back your hand in the fireing, your leg ſtanding forwards; and ſo doing, the Piece will be Loden and Fir'd Gunner-like. Some uſe to prime before the Touch-hole forwards two or three inches, and fire there; for the bigger the Touch-hole is, the more care muſt be taken in priming, and eſpecially in fireing.

What Powder is allowed for Proof, and what for Action for each Piece.

FIrſt, I will begin with the biggeſt Pieces, as with all ſorts of Canons, for proof $\frac{4}{5}$ and for ſervice $\frac{1}{2}$, of the weight of her Iron ſhot. For the Culverings, the whole weight of their ſhot for proof, and for action $\frac{2}{3}$, and for the Saker and Faulcon $\frac{4}{5}$, and for leſſer Pieces, the whole weight in action, until they grow hot; for then muſt abatement be made with diſcretion; But in proof, the leſſer pieces ſhould have once, and $\frac{1}{3}$ of the powder that the Bullet weigheth.

If Weights, Scales, and Ladles be wanting, how many Diameters of a Bullet will make a reasonable charge in Powder for any Peice named.

FOr the Canons 2 ½ for Culverings 3, and for the Saker 3 ½ for the lesser Pieces, 4 Daimeters of the Cilinder. For 3 Daimeters makes ¾, and 3 ½ makes ⅞ and four Diameters and a half makes the whole weight of a cast Iron shot, it being corn powder, which length will also serve for Cartredges for the like Pieces.

How Moulds, Formes, and Cartredges are to be made for any sort of Ordnance.

CArtredges are made of Canvas, or paper Royal; which prepared, take the heighth of the bore of the Peece, without the vent of the shot, and cut the cloth or paper of the breadth of three such heighths, and for the Canon in length three daimeters, for the Culvering four daimeters, for the Saker, Faulcon, &c. ½ of the height of their powder bores, and leaving in the midst, at the top or bottom, one other such height, to make a bottom for the Cartredge, cutting each side somewhat larger for the sewing and glewing them together, having a due respect for the augmenting or diminishing of your powder, according to the goodness or badness of the powder, and to the extraordinary over heating of your Piece. Having resolv'd for what sort of Ordnance your Carterdges are to serue, you are accordingly to have a Former of wood, turned to the height of the shot, and a convenient length longer than the Cartredge is to be: and before you paste your paper on the Former, first tallow him, so will the paper slip off without staying or tearing.

tearing. If you deal with taper-bored Guns, your Formers muſt be made accordingly tapred. If you make your Cartredges of Canvas, half a diameter more is allowed for the Seames, but if of Paper ½ or ¼ of an inch over-plus for the paſting, will ſerve being lapt once about the former, having a bottom firſt fitted upon the end of the former, which muſt be hard and cloſe paſted to the lower ſides of the Cartredge; and then the bottom paſted alſo down hard round about: then dry them well before you fill them, and mark every one with Inck or Black-lead, how high they ought to be filled, and let ſome want of their weight againſt times they are overhot, otherwiſe great danger may enſue.

To make Ladles, Rammers, and Spunges for all ſorts of Ordnance.

IT is fit every Gunner ſhould know how to trace, cut out, and alſo make up and finiſh all maner of Ladles, Spunges and Rammers, and to direct others how they ſhould and ought to be ſeverally fortifi'd, made and diſtinguiſhed, as followeth.

For double fortifi'd Canons to charge them with two Ladle-fulls, they are to be two diameters and a half of their ſhot in length from the head of the Ladle-ſtaff, which ſhall be one diameter more of plate, which muſt go about the ſaid head. The braſs-plate muſt be in breadth two diameters unto the ſaid head, where each ſide muſt have half a diameter more to incloſe the head of the Ladle-ſtaff within the plate.

The Button or Head of the Ladle-ſtaff muſt be one diameter, and of ſuch height or thickneſs, that it, together with the Braſs-plate, may be equal to the height of the ſhot (due vent abated) For Spunges their bottoms

or

or heads are to be made of ſoft faſt wood, as Aſpe, Birch, Willow, or ſuch like; and to be one diameter, and $\frac{2}{3}$ in length, and not above $\frac{2}{7}$ of the ſhots height. The reſt being covered with raw ſheep skins wool, and nailed on with copper nails, ſo that together they may fill the concave of the Piece.

The Button or Head of the Rammer muſt be turned of hard wood, in length one diameter, and $\frac{1}{3}$ of ſuch height and thickneſs, that it may fitly enter into the Piece, the ſhots vent allowed: It were the better for faſhion and ſtrength, if that $\frac{1}{3}$ next the ſtaff were handſomely turned with abatement, and a Ferril or circle of Braſs fitted thereon to ſave the head from cleaving, when as with force we ſhall ram the ſhot home. All theſe Heads and Buttons muſt be pierced $\frac{2}{3}$ with a hole for the ſtaff, an inch or more, whereinto the ſtaff muſt be faſtned, let the ſtaff be one foot longer than the concave of the Gun.

For the ordinary Canons, the Ladles muſt be of the ſame breadth, but muſt not ſurpaſs two diameters of the ſhot in length. And for the leſſened Canons, two diameters onely to load at twice, all according to the faſhion and breadth as before.

The Ladles for Culverings and Demj-culverings, have four diameters of there proper ſhot in length, and two in breadth.

The Sakers, Falcons, and Faulconets, which may at one Ladle-full be loaden, may have their diameters of ſeven diameters and a half of their ſhot in length, beſides that coverture of the head of the ſtaff, and of breadth two; as all the reſt have.

For Periors, which uſually have Chambers with Orloes $\frac{1}{3}$ and $\frac{1}{3}$ leſs in bore than their Chaſe containeth, to them three times the diameters of their Chambers may be allow'd for the length of their Ladles. *How*

How to make a Ladle for a Chambred bored Piece.

YOur Compaſſes opened to the juſt diameter of your Chamber within a part of an inch thereof, divide that meaſure juſt in two equal parts, then ſet your compaſſes to one of them, and with the one foot fixed on a paper or ſmooth board, draw with the other foot a circle, the diameter whereof will be juſt a quarter of an inch ſhorter than the diameter of the Chamber-bore, by the circumference whereof you may find out the breadth of the plate of a Ladle that is fit for ſuch a Chamber-bored Canon, by the Rule afore ſet down how to find the true breadth of the plate of any Ladle for any other Piece, in taking the three fift parts of the circumference thereof, the length ought to be twice the diameter, and $\frac{2}{3}$ parts to hold at two times the juſt quantity of corn-powder.

Example.

The diameter of the Circle drawn for any Canon, whoſe Chamber-bore is 7 inches, containeth $6\frac{1}{4}$ the circumference whereof is near 21 inches $\frac{2}{7}$ and $\frac{1}{4}$ parts thereof $12\frac{1}{4}$ and ſo much ought that Ladle to be in breadth, and in length 18 in the $\frac{2}{3}$ parts. By this Rule you may make a Ladle for any Tapred Piece.

Take this for a general Obſervation, that a Ladle 9 bales in length, and 2 bales in breadth, will near contain the juſt weight in powder that the Iron ſhot for any Piece weigheth.

How

How to find the height of the Chamber, and how to find the thickneſs of Metall round about the Chamber of any tapred Piece.

TAke a ſtreight piece of wyre, and bow the end thereof in the bottom, ſo as it may go through the touch-hole, then put it to the bottom of the bore in at the touch-hole, and with any thing mark the wyre upon the upper part of the Metall, then meaſure by your Rule how long the wyre is from the ſtroke to the end; Then put in the ſame wyre again, and put it up, ſo as the bowed end may reſt within the Cilinder, and make another mark on the ſaid wyre hard by the upper part of the metall, round about the Chamber, the which abated from the firſt ſtroke to the loweſt end, the remainder is the Diameter of the Chamber bore in that place. This needeth no Example.

To know whether the Carriage of your Piece be truly bor'd, and how to make them for any Piece.

MEaſure the length of the Cilinder of your Gun, the planks of your Carriage ought to be once and a half that length. Alſo meaſure the Diameter and the planks at the fore-end ſhould be in depth four times the Diameter, and at the end next the ground two times ½ the Diameter, and in thickneſs once the Diameter.

How you may find whether a Piece have any flaws cracks, or hony-combs,

AFter you have clear'd her, put a uſual ſearcher made of two or three ſprings, with points, like great pin-heads bending out-wards, which being bended together with your hand, until it will enter into the Piece,

Piece, and put up to the touch-hole, or bottom of the Cilinder, turning it round in putting it in, and pulling it out of the Chace, and if any honey-combs be therein, it will ſtick with the points therein. Alſo in a Sunſhine day with a Looking-glaſs, the Sun-beams may be reflected into the Chace, ſo that the flaws, cracks, and hony-combs may be diſcerned. But if the Sun ſhine not, a wax-candle put upon a half-pike will alſo ſhew them: If no flaws be found, proceed to her proof, but if any be therein, the Piece is indeed very dangerous, both in firing, and loading; and if it can poſſibly be prevented, not to be uſed at all, but with great care and good reſpect firſt had in her proof.

The allowance for vent, comparing the heighth of the ſhot with the heighth of the bore of the Piece aſſigned.

MAny Gunners hold, that a quarter of an inch ſpace between the Bore and the Bullet is vent ſuitable for all Ordnance, and not too much, nor too little. But others maintain $\frac{1}{10}$ part of the Diameter of a Pieces Cilinder is more proper and correſpondent for all ſorts of Pieces whatſoever; take which you pleaſe.

To diſpart a Piece of Ordnance.

TO diſpart a Piece, is to bring the metal at Muzzle equal with the metal at the Baſe-ring: In true founded Ordnance, the half of the Diameter of the Cilinder is her diſpart: alſo you may put a priming Iron (ſuch a one as I ſpake of before, with a Spring and Tranſom) into the Touch-hole, to the bottom of the concave there, and putting down the Tranſom hard upon the ſuperficies of the metal of the Baſe-ring, which reſting there, apply the Inſtrument to the Muzzle, and place him upon the lowermoſt edge of

the concave perpendicular, and raiſe your diſpart from the Muzzle-ring as high as the Tranſom, ſo you have laid the metal at the Muzzle in a Horizontal line with the metal at the Baſe-ring. But for niceneſs I would make another diſpart upon the Trunions, which may be thus done. Lay a piece of ſoft wax upon the Trunions, and let one raiſe it in heighth, I mean, make it longer or ſhorter, untill that the metal at the top of the Baſe-ring, the wax between the Trunions, and the Diſpart on the Muzzle-ring, be all three of a preciſe heighth, and in an equal ſtraight line direct.

If I were to fire a piece of Ordnance at a mark, to gain credit indeed thereby, I would have a twine ſilk thread that ſhould touch both the tops of the Diſparts, and come to the upper part of the Baſe-ring upon the midſt thereof, by which thread I would direct my Ordnance to the mark many degrees better.

I could wiſh that the Diſparts ſhould be skrew'd into the Muzzle-ring of the Pieces, that it might be uſed to that purpoſe, and had alwayes in readineſs belonging to the ſame Gun, and upon any occaſion taken out at pleaſure.

As in the Voyage I made this laſt Spring to the *Straits* mouth, Where we were in fight, being a ſingle Ship, with five Turky men of War.

Alſo I could adviſe the Sea-gunners upon ſome occaſions to uſe Diſparts between the Trunions of their Pieces, made of a juſt heighth of purpoſe to ſerve there: let them be tyed about the Piece with a twine, becauſe elſe at every ſhot they will be to ſeek, when upon the ſudden they ſhould uſe them; which I can by good experience ſpeak, they will much avail, and ſtand you in great ſtead. I could expreſs divers other wayes to diſpart a Piece, but theſe being ſufficient, I hold it needleſs to ſpend time, and fill this little treatiſe with unneceſſary Inſtructions.

The Geometrical finding the Daimeter for the weight of any ſhot aſſigned.

SUppoſe your ſhot be one, two, or three pound weight of metal or ſtone aſſigned, if of one pound divide the Diameter into 4 parts, and five ſuch parts will make the Daimeter of a ſhot of the ſaid metall or ſtone, that ſhall weigh juſt two pound.

Divide the Daimeter of a ſhot weigheth juſt 2 pound in 7. equal parts, and 8. ſuch parts will make a Daimeter of a ſhot of 3. pound. And divide the Diameter of a ſhot of 3. pound into 10. equal parts, and 11. ſuch parts maketh a ſhot of 4. pound

Divide the Diameter of a ſhot of 4. pound into 13. parts, 14. ſuch parts will make a Diameter for a ſhot of 5. pound.

And ſo dividing each next Diameter into 3. parts equal more than the next leſſer was divided into 3 and it will with one part added from a Diameter of a ſhot, that will weigh juſt one pound more: So you may proceed infinitely increaſing, or decreaſing, by taking one part leſs than it is appointed to be divided into.

To tertiate a Piece of Ordnance.

THere are three differences in Fortification of each ſort of Ordnance, be they of Canons, or Culverings; for they are either ordinary fortified, leſſened, or double fortified, as legitimate Pieces, baſtard Pieces, or extraordinary Pieces. For the Canon double fortified, hath fully one Diameter in thickneſs of metal at her Touch-hole, and $\frac{1}{16}$ at her Trunions, and $\frac{1}{16}$ at her Muzzle. And the leſſened Canons have at their Touch-hole but $\frac{1}{4}$ and at the Trunions $\frac{1}{16}$ and at the Muzzle $\frac{1}{16}$

whereas the ordinary fortified Canons have $\frac{7}{8}$ at the Touch-hole, and $\frac{1}{8}$ at the Trunion, and $\frac{1}{8}$ at the Muzzle. Now all the double fortified Culverings, and all leſſer Pieces in that kind, have one Diameter, and $\frac{1}{8}$ at the Touch-hole, and $\frac{1}{16}$ at the Trunions, and $\frac{2}{16}$ at the Muzzle. And the ordinary fortified Culverings are fortified every way like the double fortified Canons. And the leſſened Culverings, like the ordinary fortified Canons in all points.

The difference between the common legitimate Pieces, and the baſtard Pieces, and extraordinary.

COmmon or legitimate Pieces are ſuch Ordnance, as have a due length of their Chaſes, proportioned according to the heighth of their proper bores. Baſtard Pieces are ſuch as have ſhorter Chaſes than the proportion of their bore doth require. And extraordinary Pieces are ſuch Ordnance, as have longer Chaſes than the proportion of the bore alloweth: And theſe are called Baſtard Culverings, and extraordinary Culverings, ſo likewiſe of Saker and Faulcon.

To cool a Piece of Ordnance, when ſhe is grown hot with over-much fireing.

IF you cannot have time to reſt her, becauſe the Service is hot, as it was with us at *Bergen*, in that caſe ſhe muſt be cooled with ſpunges wet in lee and water, or water and vinegar, or with the cooleſt freſh or ſalt water, bathing and waſhing her both within and without, untill ſhe come unto her due temper; but if time would permit, reſt her one or two hours in twelve, and cool her as before every eighth or tenth ſhot.

Reaſons

Reaſons that cauſe a Shot, though well directed, to err in her charge, and to be either wide, ſhort, or over at the mark,

MAny accidents may make a Shot to deviate from the expected courſe, though well directed. As if the ſoul of the Piece lyeth awry in the body of her metal. And if the Trunions alſo be not duely placed directly in a Diagonal line with the Axis of the Piece. If the plat-form be unequal. Alſo if the Gunner ſhoot without a juſt diſpart. If one wheel be higher than another. If the naves be one longer and wider than the other. When one wheel meets with a ſtone to ſtay it: or that one wheel reverſeth in ſoft ground, and the other in hard. The Carriage or Trunion ears are higher one than another. If the Carriage be too wide, ſo that the Piece lyeth not faſt therein, but ſtarteth in her diſcharge. If the ſhot be not equally round, the wind if vehement, may ſomewhat hurt. The ſlight ramming, leaving ſpace between powder, wad, and bullet, may alter her courſe. Theſe and many more, are true and infallible cauſes of the failing of a ſhot at an aſſigned mark, yet the Piece well directed.

The difference between ſhooting by the metal of the Piece, and the Diſpart.

THeir differences are uncertain, by reaſon there are ſeldome any conſtant proportion held in the founding eſpecially concerning the Eminencies of their Muzzle and Baſe-ring: for laying the Piece directly to the mark, with her due Diſpart, and then take off that Diſpart, and lay her by the Metal, obſerve the difference with a Quadrant, and you ſhall ſometimes find that the Piece will be elevated more by the metal than

than by the Diſpart, four, five, yea, ſometimes ſix or ſeven degrees. And ſo conſequently will the Randoms of the metal be more than the Randoms of the Diſpart, (which by the Table of *Ranges*) may for every elevation be made certainly known; but this take for an example, on the level the metal rangeth near double the diſtance of the Diſpart in moſt Pieces.

To know at how many degrees of mounture a Piece will convey her bullet furtheſt, called her beſt Random.

THe approved beſt Artiſts of late times, maintain with good reaſon, that the utmoſt degree of Random is at, or about 24 degrees of the quadrant, nevertheleſs moſt ancient authors hold 45. being the middle or mean between the level and the perpendicular; namely, the half of 90. degrees. But becauſe the Piece rangeth a bullet but one tenth part of the utmoſt random as it doth alſo at 84. degrees of the elevation, therefore it ſtands with more reaſon, and experience alſo hath found, that the utmoſt random of any Piece ſhould be (being duely charged and diſcharged) at 42. degrees, the half of 84. the elevation.

A neceſſary Table of Periors and Drakes proportioned.

Names of Pieces.	Height of the bore in inches	Length in Diameter.	Weight in met. pound.	Weight of Powder.	Length of the Ladle.
Canon Perior.	9. 10. 12.	8	3500	3, 3 1/2 4	3
D. Canon Drake.	6 1/2	16	3000	9 pound.	4 1/2
Culvering Drake.	5 1/2	16	2000	5	4 1/2
D. Cul. Drake.	4 1/2	16	1500	3 1/2	4 1/2
Saker Drake.	3 1/2	18	1200	2	3 1/2

A Table truly proportioned for our English Ordnance.

Bore.	Height of Shot.	Weight of Shot.	Ladles length.	Ladles breadth.	Length of the piece.	weight of the piece.	weight of Corn Powder.	
Inches	Inches	Lib.	Inches	Inches	Foot.	Lib.	Lib.	
8	$7\frac{1}{4}$	63	24	14	12	8000	27	Canon Royal.
7	$6\frac{1}{4}$	39	22	$12\frac{1}{4}$	11	7000	18	Canon or De.
$6\frac{1}{2}$	$6\frac{1}{4}$	30	21	$11\frac{1}{2}$	10	6000	14	Canon.
$5\frac{1}{4}$	4+	15	19	9		4300	10	
5	5	$15\frac{1}{2}$	20	10	12	4400	12	Culvering.
$5\frac{1}{2}$	$5\frac{1}{2}$	20	21	11		4600	15	
$4\frac{3}{4}$	4	9	17	7		2200	6	
$4\frac{1}{2}$	$4\frac{1}{4}$	$10\frac{1}{2}$	18	8	11	2400	$7\frac{1}{4}$	De. Culvering.
$4\frac{1}{4}$	$4\frac{1}{2}$	12	19	9		2500	8	
$3\frac{3}{4}$	3	5	30	9		1400	4	
$3\frac{1}{4}$	$3\frac{3}{4}$	$5\frac{1}{4}$	31	9	9	1500	$4\frac{1}{4}$	Saker.
4	$3\frac{1}{4}$	$5\frac{1}{2}$	32	10		1600	$5\frac{1}{2}$	
3	$2\frac{3}{4}$	3	25	$5\frac{1}{2}$	$7\frac{1}{2}$	1200	3	Minion.
$2\frac{1}{4}$	$2\frac{3}{4}$	2	22	5	7	700	2	Faulcon.
$2\frac{1}{4}$	2	$1\frac{3}{4}$	18	$3\frac{1}{2}$	6	500	1	Faulconet.
$1\frac{1}{2}$	$1\frac{3}{4}$	3 4	$11\frac{1}{2}$	$2\frac{3}{4}$	4	300	$\frac{1}{2}$	Rabinet.
$\frac{1}{4}$	1	$\frac{1}{2}$	9	2	$3\frac{1}{2}$	202	$\frac{1}{2}$	Base.

A Table of Randoms for the six first poynts of the Quadrant.

	1	2	3	4	5	6
Faulconet.	375	637	795	885	892	900
Faulcon.	550	935	1166	1254	1309	1320
Minion.	450	765	954	1026	1071	1080
Saker.	625	1062	1325	1425	1487	1500
D. Culvering.	725	1232	1537	1653	1725	1740
Culvering.	750	1275	1590	1710	1785	1800
Demi-Canon.	625	1062	1325	1425	1487	1500
Canon of 7.	675	1147	1431	1489	1606	1620
Double Canon.	750	1275	1660	1710	1785	1800

FIrſt, by this Table, having reſolved upon the point of mounture, look againſt the name of the Piece, and right under that point in the common angle, you ſhall find the number of paces of her Random ſought.

A Table of the proportion of right Ranges, and firſt, what a Range is.

A Right Range in any Piece is indeed ſo far as the Bullet is carried violently in a ſtraight line, which by ſome Gunners of theſe our modern times, is by them properly called the *Right Range*. This kind of ſhooting is ſo far as a mark is within the ſtraight line of a Piece, which for ſome elevations and mountures is much more than for others: for that the more a Piece is mounted, the farther ſhe conveyeth her ſhot in a right Range.

A Table of Right-Ranges.

0	192
1	209
2	226
3	243
4	260
5	277
6	294
7	311
8	328
9	345
10	362
20	532
30	702
40	872
50	1042
60	1212
70	1302
80	1552
90	1722

The Uſe of this Table, with a plain Example.

HAving found by experience, that at 60 degrees of mounture the Piece aſſigned ſhot 200 paces in a right-line, and would know how far the ſame Piece would ſhoot in a ſtreight line being mounted to 10 degrees. Say, by the Table, If 294, the number againſt 6 degrees, giveth 200 paces, what will 362, the number therein againſt 10 degrees, give? Multiply 362 by 200, the product will be 72400, which divided by 294, produceth in the quotient 246 paces, and $\frac{256}{294}$ parts.

Of ſhooting at random at a Mark beyond the right line of the Pieces reach, or right range of the ſhot, and of the dead range of any Piece at every degree.

THe dead range conſiſteth of the addition of the right and crooked ranges together in one, and that called the dead range, which is the whole diſtance from the plat-form unto the firſt graze of the Bullets, whereby for the firſt ſix points of the Gunners Quadrant, you having the dead range of one ſhot made out of any Piece; whether it be of a Culvering, (which is between 30 and 40 diameters of her bore in length) by the range of numbers ſet againſt the letter *S* in the Table here underneath; or whether it be of the quality of a Canon, (that is between 18 and 24 diameters of her bore in length, by the rank of numbers ſet againſt the letter *C* in the ſaid Table) you may, having one ſhot, by that ſhot, and by the rule of Proportion, know the dead range of any other point of mounting ſought.

Example.

SUppoſe a Culvering that ſhooteth level 260 paces, I would know how far ſhe would convey her ſhot upon an Horizontal plain, ſhe being mounted to the third point of the Quadrant. Say by the Rule of three, if 192 (the number againſt *S*) for the level range in the Table giveth 2032, the number under the third point, what will 260 give? Multiply 2032 by 60, and divide that product by 192, and you ſhall have in your quotient 2751 $\frac{128}{129}$ for the number of paces ſhe will convey her ſhot being ſo mounted.

The Table of dead Ranges.

	0	1	2	3	4	5	6	Points
S	192	985	1623	2032	2185	2281	2300	Paces
C	201	958	1600	1983	2135	2232	2250	Paces

To know how the range of his Piece increaſeth, or decreaſeth from degree to degree.

FIrſt, you muſt find by the Table of right Ranges how much your level right range of your Piece is, which number of paces divide by 25, and multiply the quotient by 11, and the product will be the firſt and greateſt digreſſion, which is between the firſt and ſecond degrees, which divided by 40, the degree contained between the firſt degree, and 42 the utmoſt Randon, and the quotient ſheweth the number of paces that the ſhot ſhall loſe at every digreſſion, from degree to degree, to the laſt Randon, and contrariwiſe for the increaſing digreſſion from 42 degrees, the utmoſt Randon down to the firſt degree.

How to find the right Line, or right range of any Bullet, for every elevation by any one right or dead Range given for the Piece aſſigned.

AS for example, You are to ſeek the right Range of 30 degrees for that Piece, whoſe dead Range for 30 degrees is known to be 2200 paces, by it multiply the tabular number of right Ranges for 30 degrees, which are 695, and divide the product by 2150, the tabular number for 30 degrees in the Table of dead Ranges, and the quotient will be 711 paces for the right Range of that Piece mounted and diſcharged at 30 degrees of elevation.

Another Example.

SUppoſe the level right Range is given, and the right Range of 30 degrees ſought, ſay, If 192, the firſt number in the Table of right Ranges, give 695, the tabular number thereof for 30 degrees, what ſhall 197 paces give, the level right Range given be, multiply and divide, and the quotient will be 713 paces, for the right Range ſought.

To find how much of the Horizontal line is contained directly under the right Range of any ſhot.

TO find what part lyeth under the right Range at 30 degrees elevation, the right Range at 30 degrees by the precedent example, being found to be 713 paces, and the right line of 60 grades, the complement of 30 being 866, which multiplied together, and the product divided by a 1000, the whole line leaveth in the quotient 621 $\frac{218}{1000}$ for the number of paces lying directly under the right Range.

To find how much of the Horizontal line lyeth under the crooked Range of a ſhot made out of any Piece of Ordnance at any elevation aſſigned.

THe crooked Range is ſo much of the courſe or way as the ſhot maketh as it goeth Helically between the right Range and the natural motion, or before it maketh the firſt graze; And may be thus found, by deducting of the level diſtance contained directly under the right line, or right Range of any ſhot made (found by the precedent Chapter) out of the dead Range thereof, found by the Chapter before going. For the remainder will be the paces, or other meaſures lying directly under the crooked Range.

To make a good ſhot in a Piece not truly bored, and to know how much any Piece will ſhoot amiſs, the metal thicker of one ſide than another.

SUppoſe a Canon is ſaid to be two inches thicker of one ſide in her metal than another, the diſtance to the mark ſuppoſe to be 500 paces, that is, 2500 foot, the which divided by 9 foot, the juſt length of the Cilinder of the Piece, yieldeth in the quotient 277 foot $\frac{7}{9}$ that again being multiplied by $\frac{1}{2}$ the ſuperfluity of the metal being 1 inch, makes ſtill 277 $\frac{7}{9}$, which is the true demand ſought.

To

To remedy a Piece not truly bored.

SEarch the Piece with an Inſtrument to know which is the thicker ſide; then divide the over-plus of the metal in two parts, as before, ſuppoſe 2 inches, ſetting the diſpart of your Piece on that part towards the thickeſt ſide of the Pieces muzzle, and bringing the middle part of the metal at the Baſe-ring to that diſpart, and the upper part of the mark all in one line, fire her, and without queſtion you make a very good ſhot, care being taken in loading.

If the thicker part of her metal be above, then you ought to make your diſpart one inch more; if under, one inch leſs.

To chooſe a Piece to ſhoot at ſingle mark, the courſe alſo to be obſerved therein.

BY my will I would chooſe a Piece as I had formerly practiſed in, and well examined her qualities; and when I came to load her, I would not ram home her powder any thing hard, but very eaſie, leſt in taking fire it ſhould lye blowing firſt, and cauſe the Piece to ſtart from her poſition, but let her be duely directed by a true diſparture, that the axis of her bore may preciſely reſpect the mark. And laſtly, endeavour heedfully to prevent all impedimental accidents which otherwiſe may happen, and give fire.

Having found the firſt ſhot faulty to the right or left hand, over or under, to amend the next time, and make an effectual ſhot.

IF it were wide towards the right or left hand, I would place my eye on the Baſe-ring at the next time, a little more to the ſame ſide accordingly more or leſs; if it were too high, direct the diſpart under the mark as much; if too low, lay ſome ſmall ſtone, or other thing, on the higheſt of the Baſe-ring, and by that bring the

diſ-

diſpart and the mark into one with diſcretion.

How to plant Ordnance in ſecret and double Batteries, ſo they may not eaſily be diſmounted.

THey muſt be planted upon a plat-form that deſcendeth behind, that in their reverſe they may go under the vamure of the Tronier, the Tronier being vaulted, they muſt by tackles be brought up above the vamure, and opened, and fire given immediately at the opening, ſo in their reverſe they will be again under the vamure, and be free from diſmounting, ſo long as the furn-mouth and vamure is able to keep from the ruine of Counter-batteries.

Take this by the way for a note, that a Canon at a 120 paces, will pierce a Wall or Rampart, meanly ſetled, onely 10 or 20 foot, but in cloſe ſandy ground, 20 or 24 foot deep: And that a Canon may, being well fortifi'd, and diſcreetly managed, be diſcharged 100 times in one day.

Note, That a Canon with one ſhot will ruine more than a 100 hods of earth can repair.

Further note, that a 1000 ſhot made out of 10 Canons will ruine more, than 1500 ſhot can do made out of 5 Canons: And leſs can the enemy repair the firſt than the laſt; for a Canon ſhot made every eighth part of an hour, at 100 paces diſtance, will make as much ruine, as twelve men can keep in repair.

To make a ſhot in the night at a mark ſhewed you in the day; how to prepare for it.

I Would firſt lay the Piece preciſely to the mark in the day, then with a chalk line, dipt in Gum-water, I would ſtrike a right line on the upper part of the metal, from

from the breech to the muzzle, upon which I would apply a good Magnetical Needle, or Flie, with a Chart exactly divided, and note the interſection; then from the end of the line that was mark'd, or ſtricken upon the metal, I let fall plumb-lines upon the plat-form, and at the places where they touch, I knock in at each a ſmall nail. Laſtly, with a Quadrant, I obſerve the elevation of the concave, or elſe with ſome ſtaff take the perpendicular heighth of ſome mark made in the metal, as well at the breech, as at the muzzle above the ſaid two nails: and ſo you may again lay the Piece thereby, alwayes to have the ſelf-ſame poſition, and ſo ſhoot as certain at the mark by night, as by day.

To make a good ſhot at an Enemies light in a dark night, not having any Candle, or other light by.

I Would light two pieces of Match, the one as much longer as the other, as the quantity of the diſpart of the Piece, and ſet the longer upon the upper part of the Muzzle-ring, and the ſhorter upon the Baſe-ring, ſtill traverſing and quoining the Piece, untill I have brought the light of the Enemies, and the lights of the two Matches all three in one line, and ſo give fire.

To order a Piece, to make a good ſhot at a moveable Mark, as at a Ship under ſail, Boat rowing, or Horſeman riding.

TAke a Piece that will reach the Mark in a ſtreight line; then obſerve how the Mark moveth: Next, note the wind if it blows much, whether ſide-wayes, with, or againſt you, and accordingly take advantage: Then, with the diſpart conſidered, obſerve ſome clowd, or mark, or point of land that lieth in the courſe of his motion, and when according

to

to the ſwiftneſs thereof he is come ſo near it, as I gueſs the ſhot and he may meet at the Mark, I give fire: wherein remember this ſecret of Nature, That any Piece will ſhoot farther from Sea to Land-ward, than from Land to Sea-ward.

To ſhoot at a Squadron of Men, and what Piece to chooſe.

ACcording to the diſtance, I would chooſe a Piece that in a ſtreight line can reach the mark, be it with Demi-culvering, Saker, or Faulcon, and plant my Piece, if I could, parallel to the Champion plain, that the ſhot may range to ſhoot at girdle-height, unleſs the ground be ſtony; for then would I place my ſhot ſhort of them, that grazing amongſt the ſtones, the ſtones may ſpoil them more than the ſhot of it ſelf can do by much; but in no caſe would I ſhoot wide, or over them; for that were both loſs, and foul ſhame for the Gunner.

To ſhoot farther than ordinary in one and the ſelf-ſame Piece, with like quantity of Powder and Shot.

I Will gently put home the powder, and wad the ſame accordingly, then the ſhot being involved with paper, leather, okam, or ſuch like, to fill cloſe the concave of the bore, I would drive the ſhot cloſe to the powder with a good wad, putting after it a Tampion of Cork, and with a ſponge moiſtned with Oyl, I would annoint the vacant Cilinder, and ſo barricado the Piece, that it ſhould not reverſe in the diſcharge.

Of

Of Powder, Petre, and Match.

To Refine Salt-petre wet.

TAke what quantity of Salt-Petre you pleaſe, and put the ſame into a clean Cauldron, and put thereon a little fair water, and boyl them together untill it raiſe the ſcum, which take off, and keep, and let congeal and ſhoot into coolers, as at firſt it did, and what remains, boyl again with more clear water untill it congeal.

To know if Salt-petre be well Refined.

TAke and lay it on a board, and put a coal unto it, if it raiſe an azure ſcum, it is yet greaſie, if it leaves pearls, it is yet earthly: but if it burn into the board, and leave nothing but a black colour, and riſe with a long flamed ventoſity and exhalation, it is well refined.

Several wayes to know whether Powder be decayed or no, whether by moyſture or age, in part or in whole.

IT is the practick part of a Gunner really to know his Powder, and whether it be decayed or not, by mutation or corruption. And there are eſpecially three ready wayes to find the ſame. The firſt, by the ſight, the ſecond, by the feeling, and the third, and ſureſt, by fireing it. By ſight, if it be not black and dark, but bright, and inclining to a blewiſh tawny colour. By feeling, graſping it in the fiſt, it run through the fingers quickly, and avoideth the handling, and cling not together. By fire, if fired, it riſe quick, and ſpread in a moment, ſmoke little, but riſeth in a clear flaſh:

unto which add further, if it leave no feces, but carry all away, the powder is good, or elſe the contrary may be judged.

To renew Powder decayed in part.

OFtentimes in Forts, but moſt commonly and uſually at Sea, powder gathereth humid vapours, which will in ſhort time deſtroy the ſtrength and vigority thereof, and makes it of little, and ſometimes of no uſe, without renewing it; and ſometimes it may decay by age. Let therefore the Gunner firſt prove the Powder by fire, and if it make a flame with a long tail, that is, if it ſleep in its burning, more or leſs, then for every hundred pound of powder, add four pound, or ſix pound of refined Salt-petre, mixing them well together, and put them to be beaten and wrought for the ſpace of three hours, and then moyſtning, corning, and drying the ſame, as aforeſaid, proving it in meal dried, how it will riſe by fireing; and ſo doing, the powder may be made ſerviceable, if the coal be not corrupted.

To renew Powder totally decayed.

IF it be wholly decayed, lay a Rayſon Frail, or Mat in the bottom of a bucking-tub, upon a Fagot made of purpoſe, or Lathe, ſet on edge, to keep the Mat from the bottom, and put in ſtraw laid croſs-wayes: upon which pour the decayed powder, and warm water, being put thereon, and let ſtand and ſoak ten or twelve hours, that all the Salt-petre may be aſſuredly diſſolv'd: then let out the liquor tap, which congeal to petre, and thereunto add a due proportion of Coles and Sulphur, and make it into powder, as is formerly taught: for

for the Coles and Sulphur diſſolving, will remain the Straw, Frail, or Mat.

To make Powder that ſhall not waſte with time.

TAke what quantity of powder you will, and mix it with *Aqua-vitæ*, and make it up in balls, and dry them well in the Sun, or in a warm place, and keep them in an earthen pot well glazed, untill you have cauſe to uſe them. This powder will not decay, nor waſte with age.

To preſerve Powder that is good, and keep it from decaying.

I Would adviſe every Gunner to chuſe the drieſt place he can poſſible, to keep his proviſion and ſtore of powder in, and every fortnight, or three weeks at the moſt, to turn his barrels upſide down, ſo will the Petre be diſperſt in every place, and be in every part alike, otherwiſe, if it be let ſtand long unremoved, the Petre will (as nature forceth it to its proper Element) deſcend for the moſt part, to the bottom of the Barrel, and the upper part will want, and be much weakened, and in time quite decay, and loſe its proper virtue: for one pound of powder in the bottom of any Cask, with long ſtanding, will have more ſtrength than three at the top.

Alſo it were good diſcretion after you have put your powder in Cartredges, to barrel them up, and ſometimes to turn them, as aforeſaid. I would adviſe you likewiſe to place all thoſe Cartredges that you keep and made for your pieces, when they are hot, by themſelves, that you may have them at hand, when need requires.

To make extraordinary Match to fire Ordnance.

TAke as many threads of groſs Cotton-yarn, as hath not taken Salt-water, and work them bobbing-wiſe of a compleat bigneſs, and boyl them in Salt-Petre-water, and ſqueeze them, and roul them on a Table, whereon mealed Petre and Sulphur is ſpread: then draw them through the palm of your hand, and dry them well. You may do it alſo with Cotton match.

To make a match will reſiſt fire and water.

TAke Salt-petre refined one part, Sulphur ½ part, and put them into a pot with ⅓ parts of Camphire mealed with the Sulphur, and one part of fine mealed quick lime, with ſo much Lin-ſeed Oyl and a little liquid varniſh to temper them well together. Then take of Cotton bobbing match, as big as your little finger, and put it into the mixture to ſoke over a fire untill it be well imbibed, and have ſoked up the moſt part of the liquor, then take the feces or remainder, and put them into the palm of your left hand, and with your right draw the match through it twice or thrice, claſping cloſe your fiſt, that the match may receive the ſubſtance of it thereinto: then dry it upon a line, and keep it for ſpecial uſes, for Vaults, Mines, and moiſt weather.

To make a very violent Match.

TAke two ounces of Powder, four ounces of Petre, two ounces of *Aquavitæ*, diſſolve them over a fire, and put in your Cotton-match, and ſoak it up: If you imbibe the feſills of your rockets therein, it will be very proper; you may rowl and rub them in meal powder upon a table dry, and keep them in a dry place, and it will be for your purpoſe.

Of

Of Fire-works.

To make certain Fire-works, very neceſſary both for Sea and Land-ſervice.

TO arm Pikes, to defend a ſhip, or breach, or to enter the ſame, or to ſtick in the ſides of a ſhip, or other place, take ſtrong canvas, and cut it in length about a foot, or 14. inches, and ſix inches high in the Center, and let the ends be both cut taper-wiſe, then faſten the Canvas at both ends with ſtrong twine, and fill it with this receipt.

Powder bruiſed 8. parts, Petre in Roch 1. part, Petre in meal 1. part, Sulphur in meal two parts, Rozen Roch three parts, Turpentine 1. part, Verdigreaſe ½ part, Bole-armonick ⅓ part, bay ſalt ⅓ part, *Colophonia* ⅙ part, Arſnick ⅛ part, mix them very ſuently together, and try them in the top of a Braſs Candleſtick when the fire doth burn furiouſly with a blew and greenish colour, then fill the Canvas, and roul it over, being firſt armed with ſtrong twine all over, with this liquid mixture molten in a pan, Pitch four parts, Linſeed-Oyl 1 part, Turpentine ⅓ part, Sulphur 1. part, Tarr ⅓ part, Tallow one part; and as ſoon as this is cold, bore two holes in each of the ſame next the Iron an inch deep, with a ſharp Iron Bodkin, filling the ſame with fine bruiſed powder, and putting in every hole a little ſtick of two inches long, which are to be taken out when you would fire the ſame, this compoſition will burn furiouſly.

And remember you cut off the ſtaff ſome three inches

ches from the work, and put thereon a braſs ſocket of five or ſix inches long, and then cut the end of your ſtaff to fill the ſocket, for when you fire your work, you may ſtick it in the ſide of a ſhip, and pull the ſtaff out again, ſo will not the work be ſo eaſily avoided, as when the ſtaff was on, and hangs at length, becauſe the very weight of the ſtaff and length thereof, will be a means to weigh down the work, or that the Enemy may come, and thereby pull it out, or beat it off quickly; let the compoſition and work contain in weight about 7. pounds, then will it do execution, and work a better effect, than if it were of leſs weight, by much; by reaſon the compoſition elſe would be waſted, before it comes to effect its Execution.

To burn the ſayls of Ships a pretty diſtance, or to fire thatch'd houſes, Corn-ſtacks, or any other combuſtible matter apt to burn, when you cannot come to the ſame; it is good to have certain ſtrong Croſs-bows to bend with Racks or Gaffels, and ſo ſhoot Arrows, armed at the Heads with Wild-fire, made of the compoſition as above, and about three inches in length, and one inch and a half in the Diameter, tapred as afore in all points: or you may have long bows, but then let your Arrows be alſo longer, which for divers ſervices may do great good.

To charge Trunks.

TO charge Trunks to ſhoot little Balls of wild-fire either to offend or defend, you muſt firſt charge him with two inches of good Powder, and then with a Ball of wild-fire a little lower than the concave of the Trunk, let the Ball be bored through croſs-wayes, and primed

primed full of fine powder. Laſtly, with ſlow receipt, then with powder, then with a Ball again as aforeſaid, untill you have filled the ſame within $\frac{1}{4}$ of an inch of the mouth, which would be filled up with fine powder and receipt mixt together. Some do uſe to have at the mouth two Iron ſtirts to ſtick them in the ſide of any thing, or to defend ones ſelf from the Enemy from taking it off with a thruſt while they do Execution.

To make the Ball.

THe Ball of Wild-fire muſt be thus made. Take untwiſted Match, Tow, and Hemp, the which would be moyſtned in *Aquavitæ*, or boyled in Salt-petre water: then take of bruiſed Powder ſix parts, of Salt-petre one part, of Brimſtone finely beaten one part, of coal made of light wood moyſtned with a little Linſeed-oyl and Turpentine wrought together, one part: then lay the Tow, or Okam abroad in thickneſs of the back of a knife, and as broad as a great Oyſter-ſhell, put into the ſame as much as you can graſpe together in your fiſt, and tying the ſame hard with a pack-thread, coat it over with molten Brimſtone, and when you would uſe the ſame, bore it through with a Bodkin, and fill the holes full of fine Powder bruiſed.

To make Bullets of Wild-fire to ſhoot out of a Trunk, which will be as hard as a ſtone.

TAke Sulphur in meal ſix parts, of Rozen in meal ſix parts, melting the ſame in ſome Pot over a ſlow fire: then take ſtone pitch one part, of hard wax one

one part, of Tarr ¼ part, of *Aquavitæ* ⅛ part, of Linſeed-Oyl ⅛ part, of Verdigreaſe ¼ part, of Camphire ⅛ part, melting all theſe together. Likewiſe ſtir in to the ſame of Petre in meal two parts, and taking it from the fire, put therein four parts of bruiſed powder, working the ſame well together in your hands, and roul it roun 1 of the bigneſs you mean to make your balls of, boaring two holes through the ſame croſs-wayes, which muſt be primed with bruiſed powder. Theſe balls being cold, will grow very hard, and fired will burn furiouſly.

To make Hedge-hoggs.

TO make Hedge-hoggs, or Balls, you muſt fill them with the ſame receipts you do your Arrows, and Pikes, and let them be five inches in the Diameter, and well armed with twine before you coat them, and after boared two holes, and primed with fine powder: then put in two ſticks, and uſing them, pull them out again, and at the ſaid holes fire them. The ſpikes end of Iron muſt be like Deaths Arrow heads, five or ſix ſtirts apiece, to hang in the ſayles, or ſtick in or upon any place aſſigned; and remember in the arming, to leave a nooſe to throw him being fired, out of your hand.

To make Powder-pots.

THey are made of black Potters clay, or thick glaſs, round Bottles with ears to tye matches, lighted at both ends, the pots or glaſſes are to be filled with dry fine powder, and thrown upon the decks, or other where, which will much prejudice the Enemy, and many times fire their own Powder-cheſts.

To make Powder-Cheſts.

THey are to be made firſt of three boards, two to be nailed together like the ridging of a Houſe, and one longer and broader to the bottom thereof: between which three boards put your Cartredge, then make it up like a Sea-cheſt, and fill in with ſtones, nailes, and what ſuch like you will: then nail the cover on, and the ends to the decks, in ſuch a place that yau may fire the powder underneath through a hole made to put a Piſtoll in.

To make Roch-Sulphur.

ROch-Sulphur is made, one pound of Sulphur molten on a ſlow fire, and one quarter of a pound of mealed Powder put thereto by little and little, and in the cooling put three ounces of Corn-powder, mixing them well together; to which put one pound of molten ſuet, ſo have you made good Roch-Sulphur.

A true Receit of a Compoſition that will burn and feed upon the Water.

TAke Maſtick half a pound, white Frankinſence, Gum, Sandrake, Quicklime, Brimſtone, Bitumen, Camphire, and of the beſt and dryeſt Gun-powder, of each of theſe one pound and a half, Rozen one pound, Salt-petre four pounds and a half; mix them all together, and you have your deſire.

A Receit of a Compoſition that will burn under water.

TAke Brimſtone one pound, Gun powder ten ounces, of the beſt Salt-Petre you can get, one pound

and a half, Camphire beaten with Sulphur and Quick-ſilver; mix them well together with oyl of Petre, or for want of it, let it be Linſeed oyl boiled, until it will ſcald a feather: fill a Canvas ball with this Compoſition, arm it, and ballaſt it with Lead at the bottom, make a little vent at the top, fire it well, and caſt it into the water, and you ſhall find the Experience worth your labour.

A Receit of a Compoſition that will kindle with the water.

TAke of Oyl of Tyle one pound, Linſeed-oyl three pounds, Oyl of Yolk of Eggs one pound, new quick-lime eight pounds, Brimſtone two pounds, Camphire four ounces, Bitumen two ounces; Mingle all together very well, and you ſhall have your deſire.

How to know the juſt time or hour, that any quantity of a lighted Match ſhall do execution at the time deſired.

TAke our ordinary Match which is uſed for the Musket, rub, or beat it againſt a poſt to ſoften it, then either dip the ſame in the water of our ordinary Salt-petre, then dry it very well either by the fire, or in the Sun, according as your haſte requires: or elſe beat a little Brimſtone very ſmall, and put a little fine Gun-powder amongſt it, and rub the Match with them, being made liquid with a little *Aqua vitæ*, and dried as before-ſaid: then try firſt how long one yard of this Match thus prepared, will burn, which imagine to be about a quarter of an hour; and if one yard will burn ſo long, then four yards will be juſt an hour: Take therefore as much of this Match as will burn ſo long as you will have it to be ere your Work ſhould fire, bind the one end unto your Work, lay looſe powder well dryed under, and about

about it lay the reſt of the Match in hollow or turning, ſo that one part of it touch not another, and fire it.

For Fire-pikes 4 pound a piece for one dozen.

Powder 20 pound.
Petre-roch 5 pound.
Petre-meal 5 pound.
Sulphur 3 pound.
Rozen 2 pound ½
Turpentine 1 pound.
Linſeed-oyl 1 pound.
Sum 38 *pound* 8 *ounces.*

For arming.

Sulphur 6 pound.
Turpentine ½ pound.
Thread 4 pound.
Sum 10 *pound* ½

For Arrows 2 dozen, each 1 pound.

Powder 12 pound.
Sulphur ¼ of a pound.
Rozen ¼ of a pound.
Roch-Petre half a pound.
Petre-meal ¼ of a pound.
Sum 14 *pound* 3 *quarters.*

For Coating.

Sulphur 5 pound
Petre-Roch 2 pound.
Petre-meal 1 pound
1 yard of Canvas & Marl.
Sum 8 *pounds.*

For 2 dozen of Balls wet-works of 4 pound a Piece.

Powder 48 pound.
Petre-Roch 16 pound.
Pitch 2 pound.
Rozen 2 pound.
Turpentine 8 pound ½
Linſeed-oyl 1 pound.
Train-oyl 1 pound.
Sum total 78 *pound* ½

For Coating.

Pitch 14 pound.
Rozen 2 pound.
Sulphur 8 pound.
Canvas 4 yards.
Small Marl 3 pound.
Sum 31 *pound* ½

For 1 dozen of pots, each one 1 pound.

Corn-powder 1 pound ½
Serp. powder 9 pound.
Sulphur 3 pound.
Petre-Roch 1 pound and ½
Sum 15 *pound.*

For Capping:

Canvas 1 yard.
Okam ¼ of a pound.
Sulphur ¾ pound.
Packthred 1 ounce.
Sum 1 *pound* 9 *ounces.*

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